

Outline for Meeting with COGCC and CDPHE Re: Mamm Creek Field Well Integrity Discussion

Overarching Goals

- Ensure that new wells are constructed to minimize the likelihood of fluids or gas migrating to shallow aquifer and Divide Creek (both Williams Fork production gas and non-productive deep Wasatch gas). Ensure that existing wells with recognized casing and/or cement concerns do not act as a conduit for migration of fluids or gases into the Wasatch Formation aquifer.

Key Issue/Concern/Question:

Based on EPA's review of information provided earlier this year by a concerned citizen and of more recent work done by COGCC and other parties, EPA has continuing questions about impacts to the Wasatch Formation aquifer and drinking water wells potentially resulting from production wells that do not effectively protect the aquifer.

Meeting Purpose:

- Better understand the work that OGCC has conducted over the last 2 years including the recommendations being made for new production well requirements and investigation and remediation of existing production well integrity;
- Explain recent analysis by EPA and questions it raises
- Discuss questions, concerns, information gaps, etc
- Determine next steps

Background:

- July 2008: EPA received letter from Ms. Bracken requesting that we investigate West Divide Creek seep. She specifically requested that we take steps to determine whether groundwater near her property was contaminated.
- Jan-Sept 2009: EPA, CDPHE and COGCC had a series of conversations and meetings regarding coordination on oil & gas-related citizen complaints, including Ms. Bracken's
- April 2009: EPA made initial visit to Divide Creek area to:
- Visually survey 2004 seep remediation area and alleged 2008 seep; EPA noted that some domestic wells near the 2008 seep area showed thermogenic methane
 - EPA notified COGCC in advance of visit
- April 2010: EPA visited Divide Creek area with COGCC and Garfield County staff to:
- Resurvey the area looked at in 2009
 - Received a short presentation from COGCC and Encana staff on NTOs and COAs for the Mamm Creek area.
- Summer 2010: EPA began production well data analysis for >300 wells- initially near Miller domestic wells. Goal was to assess well integrity to determine whether wellbores might be acting as possible conduits for fluid movement. COGCC later asked EPA to include additional

wells near Moon domestic well.

Fall 2010: EPA accompanied by USGS met with COGCC to share well analysis and discuss findings. Primary observations were:

- Setting surface casing depths relied on “X + 50 ft” where X equals the depth of the nearest drinking water well within 1 mile of the proposed gas well.
- Surface casing did not extend to the bottom of the Wasatch formation. The Wasatch Formation is defined as a USDW by EPA and used throughout the area by residents for drinking water and other water supply needs (e.g. livestock)
- Production casing cement does not extend from the bottom of the Wasatch Formation vertically up behind the surface casing shoe.
- In many of the production wells EPA reviewed, the annulus is uncemented from the top of the production casing cement to the surface casing shoe. This open annulus is located in the Wasatch Formation. In some parts of the field, shallow non-commercially producible gas exists through this uncemented zone.
- The potential for deeper Wasatch gas shows were determined to likely exist by EPA’s petroleum engineer and COGCC.
- USGS Scientific Investigations Report 2010-5215: The study provided evidence for movement of water, ions, and gases into the shallow Wasatch Formation from sources such as the Mesaverde Group and the deeper Wasatch Formation.
- These observations raised further questions about whether the casing and cement program employed in the field was effectively preventing movement of water, ions and gas into the shallow Wasatch Formation aquifer.

Winter 2010: In response to these preliminary findings, COGCC undertook further well integrity analysis with consultant in an area near the EPA evaluation area

June-Sept 2011: COGCC’s contractor completed the well integrity study, and COGCC staff responded to study recommendations.

Feb 2012-present:

Ms. Bracken has continued to contact EPA with ongoing concerns regarding groundwater contamination and seeps in Divide Creek. She provided additional data collected in 2004 by COGCC, EnCana and a contractor that EPA had not previously seen. EPA staff indicated to Ms. Bracken that the additional data would be reviewed as well as the COGCC June 2011 report and confer with COGCC on overall status of actions.

EPA notes that COGCC has taken numerous actions between March 2004 when original Divide Creek seep occurred and the present to attempt to address the concerns with production well construction and fluid or gas migration, including:

- 2006-2010: Created new and updated existing NTO’s
- 2011: Added additional stipulations and COAs (conditions of approval) to the APDs

Materials Reviewed by EPA

EPA reviewed:

- June 20, 2011 *East Mamm Creek Project Drilling and Cementing Study* (“EMC Study”) and

recommendations

- September 19, 2011 COGCC Response to the conclusions and recommendations in the EMC Study
- Notices to Operators and Conditions of Approval for Mamm Creek and adjacent fields currently posted on COGCC website
- Data not previously seen by EPA provided as part of Ms. Bracken's submittals
 - 2004 isotopic and chemical data from 35 domestic wells, irrigation wells, ponds, a seep, production wells and 23 monitoring wells. Samples were collected by COGCC, Encana and Cordilleran (Encana contractor).

Key EPA Observations and Questions Based on EPA's 2012 Review

Surface casing for new wells

OBSERVATIONS:

The current surface casing requirements appear to encompass contradictory approaches within the same APD. All or some combination of the following surface casing requirements are included in the APDs reviewed by EPA: setting casing to $x + 50$, where x is the nearest drinking water well depth within a 1 mile radius; setting casing to 15% of TD or 500 ft below water well in 1 mile radius; setting casing to 10% of the total depth of well; and/or setting surface casing a minimum of 50 ft below Molina member of the Wasatch Formation.

QUESTIONS FOR DISCUSSION:

EPA has several questions and observations regarding the surface casing requirements and their ability to protect the Wasatch Formation aquifer:

- Which of these requirements applies in what situations? If more than one requirement is in a given APD, how does the operator choose the requirement to follow?
- How was the Molina member determined to be a competent confining layer? From a literature search, it appears to be a sandstone member that may not be continuous.
- Since none of these requirements for surface casing placement are based on local hydrogeologic conditions, how can we be sure that the Wasatch Formation aquifer is isolated from fluid and gas movement along the wellbore through the uncemented annulus? Would additional requirements help to ensure drinking water aquifers are isolated?
- Are operators drilling with heavy mud for surface casing (over pressured)? How are operators ensuring during the surface casing installation that they are not propagating fractures in the Wasatch Formation?

PRELIMINARY SUGGESTIONS AND RECOMMENDATIONS:

- Overall goal is to construct a well where (good) cement is present from confining layer within the Williams Fork Formation to the surface and avoid propagating fractures in the Wasatch Formation.
- Clarify terminology for aquifer, aquifer system and confining unit. Consistency with Safe Drinking Water Act regulatory threshold for an Underground Source of Drinking Water (USDW) is desirable.
- When water supply wells are drilled, the owner/driller will typically stop drilling at the initial discovery of sufficient yield of fresh water. Given that, the water supply well cannot be used as a

surrogate to identify the bottom of the aquifer. Setting surface casing at $x + 50$ is not a conservative rule of thumb and cannot be assumed to protect the aquifer or the well.

Hydrogeological conditions must be understood and taken into consideration when designing casing and cementing requirements. In the absence of hydrogeological data, a conservative approach would be to require (good) cement through the entire Wasatch Formation.

- Set surface casing into the bottom of the Wasatch. (If this approach is used—a CBL or radial log would be necessary to verify the quality of cement behind casing). EPA recognizes this may be technically infeasible given the depth and the inability to extend surface casing below the kick-off point for directionally drilled wells.
- Require intermediate casing to isolate the zone between the surface casing shoe and the top of a confining unit in the Williams Fork Formation (or the top of production casing cement). Both of these casing strings should have adequate cement behind casing (CBL to verify).
- Drill surface casing with an air rig to decrease the likelihood of fractures being propagated in the Wasatch Formation.

Production casing cement for new wells

OBSERVATIONS:

In the New Mamm Creek Field Notice to Operators (July 2004, **Feb 2007**), production casing cement is required to be set to 500 feet above the TOG. Based on EPA review of COGCC data, it appears that operators are using the top of commercially producible gas to define TOG.

QUESTIONS FOR DISCUSSION:

- How is the TOG determined? A recent COA added to some APDs reviewed by EPA requires cement to 500 feet above ‘shallowest gas signature’ defined as 2500 units. Would this capture gas shows observed in the EPA evaluation at around 900 feet bgs?
- How are the current NTOs addressing Wasatch gas (observed at ~ 900 feet) or shallow non-commercial Williams Fork gas through construction requirements?

PRELIMINARY SUGGESTIONS AND RECOMMENDATIONS:

- Require intermediate casing with adequate cement (CBL needed) to isolate the gas-bearing zones above commercial TOG.
- Identify over and under pressured zones and design a cementing program via staging to better ensure adequate cement behind pipe

Monitoring and remediation of existing wells

OBSERVATIONS:

EPA reviewed current COGCC records for ~25 existing wells that our previous analysis indicated had cement issues that could potentially allow shallow gas migration. Of those, none had any records indicating they had undergone remedial cementing; rather, it appears that the approach is to monitor bradenhead pressure, and vent as needed. Remedial cementing appears to be *considered* only for those wells whose bradenhead pressure is >150 psi, despite the fact that the 2010 East Mamm Creek report indicated that remedial cementing was effective at reducing or eliminating fluid migration.

QUESTIONS FOR DISCUSSION:

- Is the bradenhead monitoring required by the 2010 Bradenhead NTO intended to be the sole means of identifying fluid movement potential? EPA is concerned that bradenhead testing alone may not identify all problems with fluid movement.
- Is there a potential that 150 psi identified at the surface is an indicator that inter-formational fluid movement could be occurring?
- Have any wells exhibiting >150 psi undergone remedial cementing? Does COGCC intend to remediate additional wells with cement problems? EPA is concerned that simply venting bradenhead pressure may not address movement of other fluids, and that unremediated wells may continue to act as fluid conduits.

PRELIMINARY SUGGESTIONS AND RECOMMENDATIONS:

- Conduct temperature logs on production wells that show elevated bradenhead pressures
- Operators are required to report bradenhead pressures by Nov 1st via NTO: Buzzard, Mamm Creek, and Rulison Fields, Garfield County and Mesa County (July 2010)). Are there any locations where pressures can be attributed to geologic feature? If so, should consideration be given to other areas with similar geology in Garfield County that have not been investigated?

Issues identified in groundwater sampling

OBSERVATIONS:

Sampling data from COGCC, Encana and Cordilleran (provided recently to EPA by Ms. Bracken) and from USGS appears to indicate a fairly widespread incidence of both thermogenic gas and deep Wasatch biogenic gas impacting drinking water wells (see map). Elevated chlorides and TDS suggest that other fluids may also be moving from deeper to shallower zones in multiple areas, suggesting impacts beyond those caused by specific well failure incidents.

QUESTIONS FOR DISCUSSION:

- Given the lack of cement behind pipe in the lower Wasatch, how can COGCC be sure that fluids are not moving up wellbores and causing these impacts?
- Have these domestic wells been re-sampled since 2004? If so, do results show improvement?
- Have drinking water wells and/or springs in Garfield County outside of West Divide Creek area been sampled for gas and TDS? If so, where, and what were the results? Is there a potential for a more widespread occurrence?
- Have more recent Divide Creek seep areas been sampled and demonstrated to be shallow biogenic gas rather than deep Wasatch gas?

PRELIMINARY SUGGESTIONS AND RECOMMENDATIONS:

- Given the indication that fluid migration impacts may be more widespread, we suggest COGCC consider applying more stringent isolation practices, such as intermediate casing discussed above, across a wider area rather than limiting enhanced practices to the East Mamm Creek area.
- Consider remedial cementing to eliminate gas and/or fluid migration behind casing
- Consider ongoing monitoring of groundwater/domestic wells to evaluate the effectiveness of newer construction conditions at reducing or eliminating fluid migration.

OVERALL STATEMENT OF EPA CONCERN

- Previous well construction practices and even updated practices required by revised Notices to Operators do not require cement that fully isolates the Wasatch and other potential drinking water aquifers, and data show evidence of impacts from gas migration and migration of production fluids.

WHAT IS ACHIEVABLE NOW THAT IS PROTECTIVE OF THE CURRENTLY USED USDW

- Use existing information to establish where a laterally continuous confining zone exists near the top of the Mesa Verde or the bottom of the Wasatch formations. Require that production wells be cemented throughout the entire Wasatch Formation from this identified confining zone to surface. This would be fully protective of the Wasatch Formation aquifer that is currently being used.

Next Steps

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